

UČNI NAČRT PREDMETA / COURSE SYLLABUS

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| Predmet: | SINTEZNE TEHNIKE V ORGANSKI KEMIJI |
| Course Title: | SYNTHETIC TECHNIQUES IN ORGANIC CHEMISTRY |

| Študijski program in stopnja Study Programme and Level | Študijska smer Study Field | Letnik Academic Year | Semester Semester |
|-----------------------------------------------------------|-------------------------------|-------------------------|----------------------|
| VŠŠP Kemijska tehnologija, 1. stopnja | / | 2. | 4. |
| PSP Chemical Technology, 1 st Cycle | / | 2 nd | 4 th |

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: KTSI6

| Predavanja Lectures | Seminar Seminar | Vaje Tutorial | Klinične vaje Work | Druge oblike študija | Samost. delo Individual Work | ECTS |
|------------------------|--------------------|------------------|-----------------------|-------------------------|---------------------------------|------|
| 15 | 15 | 45 LV | / | / | 75 | 5 |

Nosilec predmeta / Lecturer: izr. prof. dr. Janez Cerkovnik / Dr. Janez Cerkovnik, Associate Professor

Jeziki / Languages:

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| Predavanja / Lectures: | slovenski / Slovenian |
| Vaje / Tutorial: | slovenski / Slovenian |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.

Prerequisites:

The course has to be assigned to the student.

Vsebina:

1) Laboratorijske operacije

Uvod: varnost, uporaba in čiščenje steklovine ter aparatur v organskem laboratoriju, ravnanje z odpadki in nevarnimi snovmi, laboratorijski dnevnik in kemijska literatura.

2) Aparature in tehnike pri kemijskih reakcijah:

sestavljanje aparatur, uporaba inertne atmosfere, merjenje in kontrola osnovnih reakcijskih parametrov, dodajanje reagentov, koncentriranje, izolacija produktov.

3) Tehnike pri sintezi in transformaciji na nekaterih primerih:

- Izomerizacija adamantana
- Priprava cikloheksanola iz cikloheksena in

Content (Syllabus outline):

Laboratory operations

Introduction: safety, using and cleaning of glassware and apparatus in organic chemistry lab, disposal of waste and hazardous chemicals, the laboratory notebook, and the chemical literature.

Apparatus and techniques in chemical reactions

Assembling the apparatus, use of an inert atmosphere, measurement and control of basic reaction parameters, addition of reagents, concentration, and isolation of products.

Techniques in synthesis and transformations using some examples

cikloheksanona

- Reakcije cikloheksanola (eliminacija, substitucija, redukcija)
- Priprava halidov iz alkoholov (t-butyl klorid iz t-butil alkohola)
- Reakcije esterifikacije (salicilna kislina, glukoza)
- Adicija diklorokarbena na alkene z uporabo katalizatorja faznega prenosa
- Grignardova reakcija: priprava alifatskih alkoholov in trifenilmetanola iz benzofenona
- Priprava amidov
- Friedel-Craftsova reakcija
- Priprava in reakcije diazonijevih soli
- Diels-Alderjeva reakcija
- Wittigova reakcija
- Priprava luminola (kemoluminiscenčna reakcija)

4) Tehnike in sinetze, ki vključujejo zaporedje reakcij (opravljanje v okviru seminarske naloge in vaj)

- Tetrafenilciklopentadienon
- Pretvorba steroidov
- 1-bromo-3-kloro-5-jodobenzen
- Sulfanilamid
- Sinteza 2,4-dinitrofenilhidrazina;
- Pretvorba steroidov (holesteril acetat – efekt tekočih kristalov);
- Iskanje spojin in sinteznih postopkov z uporabo literarnih virov in podatkovnih baz

5) Sodobne analizne tehnike v organski kemiji

Spoznavanje in uporaba sodobnih kromatografskih, spektroskopskih (UV-Vis, IR, NMR) in masno-spektrometričnih metod pri zasledovanju in kontroli organskih reakcij ter karakterizaciji produktov.

Isomerisation of adamantane, preparation of cyclohexanol from cyclohexene and cyclohexanone (oxidation), reactions of cyclohexanol (elimination, substitution, reduction), preparation of halides from alcohols (*tert*-butyl chloride from *tert*-butyl alcohol), esterification (ethyl acetate), addition of dichlorocarbene to alkene using phase transfer catalyst, the Grignard reaction (preparation of aliphatic alcohols and triphenylmethanol from benzophenone), preparation of amides, preparation and reactions of diazonium salts, Diels-Alder reaction, Wittig reaction, preparation of luminol (chemiluminescent reaction).

Experiments that use a sequence of reactions (individual work as seminars and synthesis from the literature)

Tetraphenylcyclopentadienone, 1-bromo-3-chloro-5-jodobenzen, 2,4-dinitrophenylhydrazine, transformation of steroids (holesteryl acetate – liquid crystals), searching of compounds and synthetic methods using literature and databases.

Modern analytical techniques in organic chemistry

Understanding and application of modern chromatographic, spectroscopic (UV-Vis, IR, NMR) and mass-spectrometric methods in the pursuit and control of organic reactions and characterization of products.

Temeljna literatura in viri / Readings:

- (1) A. Ault: *Techniques and Experiments for Organic Chemistry*, University Science Books (6th ed.), 1998.
- (2) J. W. Lehman: *Student Lab Companion: Laboratory Techniques for Organic Chemistry*, Prentice Hall, 2008.

Cilji in kompetence:

Cilji predmeta:

Študent nadgradi osnovno teoretično znanje organske kemije s spoznavanjem, razumevanjem in izvajanjem nekaterih najznačilnejših in najpogosteje

Objectives and Competences:

Objectives:

Build upon basic theoretical understanding of organic chemistry with recognizing, understanding, and performing of some most

uporabljenih sinteznih tehnik v organski kemiji ter pridobi osnovne veščine, ki so pri tem potrebne.
Predmetno specifične kompetence:
 - uporaba literaturnih virov in baz podatkov
 - poznavanje sinteznih tehnik v organski kemiji
 - priprava in izvedba nekaterih srednje zahtevnih eksperimentov
 - poznavanje sodobnih analiznih tehnik

frequent synthetic and analytic techniques in organic chemistry, and gaining of some basic manual skills.
Competences:
 - ability to use literature sources and databases;
 - familiarity with various synthetic techniques in organic chemistry;
 - ability to prepare and perform some intermediate pretentious experiments;
 - knowledge of modern analytical techniques.

Predvideni študijski rezultati:

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| <p><u>Znanje in razumevanje</u> Znanje: - samostojno obvladovanje osnovnih laboratorijskih operacij in tehnik; - samostojno načrtovanje, priprava in izvedba enostavnejših kemijskih pretvorb po pravilih varnega dela v laboratoriju. Razumevanje teoretskih osnov enostavnejših kemijskih pretvorb in samostojno odločanje pri uporabi ustreznih laboratorijskih tehnik.</p> |
| <p><u>Uporaba</u> Študent utrdi osnovo znanja, ki ga je pridobil pri Praktikumu iz kemije ter ga nadgradi z tehnikami, ki se najpogosteje uporabljajo ne samo pri izvajanju pretvorb v sinteznih laboratorijih, temveč tudi v drugih kemijskih laboratorijih.</p> |
| <p><u>Refleksija</u> Študent bo na osnovi pridobljenega znanja pridobil občutek za samostojno načrtovanje, pripravo in izvedbo enostavnejših in srednje zahtevnih laboratorijskih operacij pri pretvorbah organskih spojin. Ob tem bo razumel in se zavedal nevarnosti ter tveganj uporabe posameznih tehnik pri laboratorijskem delu.</p> |
| <p><u>Prenosljive spretnosti</u> Pravilno izbiranje in izvajanje osnovnih laboratorijskih operacij ter smiselna uporaba primernih tehnik. Rokovanje z občutljivimi snovmi in delo v inertni atmosferi.</p> |

Intended Learning Outcomes:

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| <p><u>Knowledge and Comprehension</u> Knowledge: -self-mastery of basic laboratory operations and techniques; -independent planning, preparation and execution of simple chemical transformations under the rules of safe work in the laboratory. Comprehension of the theoretical basis of simple chemical transformations and independent decision-making in the use of appropriate laboratory techniques.</p> |
| <p><u>Application</u> Students enhance their basic knowledge gained in Practicum in organic chemistry and upgrade the knowledge with the techniques that are most commonly used, not only in the implementation of transformations in synthetic laboratories, but also in other chemical laboratories.</p> |
| <p><u>Analysis</u> The student will gain, based on acquired knowledge, the sense of self-planning, preparation and execution of simple and moderately complex laboratory operations in the conversion of organic compounds. At the same time, he/she will understand and be aware of the dangers and risks of using specific techniques in the laboratory work.</p> |
| <p><u>Skill-transference Ability</u> Proper selection and application of basic laboratory operations and meaningful use of appropriate techniques. Handling of sensitive materials and work in an inert atmosphere.</p> |

Analiza, sinteza in poročanje o delu in dobljenih rezultatih.

Analysis, synthesis and reporting on the work and the results obtained.

Metode poučevanja in učenja:

Predavanja, seminarske in laboratorijske vaje

Learning and Teaching Methods:

Lectures, seminar and laboratory exercises

Načini ocenjevanja:

Opravljenе vaje in seminar (priprava in izvedba sinteze po literaturi) in pisni izpit.
10 (odlično), 9 in 8 (prav dobro), 7 (dobro), 6 (zadostno), 5-1 (nezadostno)

Delež (v %) /
Weight (in %)

Assessment:

Tutorials, seminar (preparation and execution of the synthesis from the literature) and written exam.
10 (excellent), 9 and 8 (very good) 7 (good) 6 (sufficient), 5-1 (inadequate)

Reference nosilca / Lecturer's references:

- **CERKOVNIK, Janez**, PLESNIČAR, Božo. Recent advances in the chemistry of hydrogen trioxide (HOOH). Chemical reviews, ISSN 0009-2665. [Print ed.], 2013, vol. 113, no. 10, str. 7930-7951, ilustr. <http://pubs.acs.org/doi/ipdf/10.1021/cr300512s>, doi: 10.1021/cr300512s. [COBISS.SI-ID 1615407]
- TUTTLE, Tell, **CERKOVNIK, Janez**, KOLLER, Jože, PLESNIČAR, Božo. The search for protonated dihydrogen trioxide (HOOH) : insights from theory and experiment. The journal of physical chemistry. A, Molecules, spectroscopy, kinetics, environment, & general theory, ISSN 1089-5639, 2010, vol. 114, no. 30, str. 8003-8008, doi: 10.1021/jp103882e. [COBISS.SI-ID 34295813]
- **CERKOVNIK, Janez**, PLESNIČAR, Božo, KOLLER, Jože, TUTTLE, Tell. Hydrotrioxides rather than cyclic tetraoxides (tetraoxolanes) as the primary reaction intermediates in the low-temperature ozonation of aldehydes. The case of benzaldehyde. Journal of organic chemistry, ISSN 0022-3263, 2009, vol. 74, no. 1, str. 96-101, doi: 10.1021/jo801594n. [COBISS.SI-ID 30098181]